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Centro Nacional de Supercomputación

Earth Sciences Department at the BSC

Road transport measures to improve air quality

Possible collaborations with SEAT

March, 2015

- Objective
- Introduction.
  - BSC and the Earth sciences department.
  - Air quality modelling.
- Tools
- Assessment of road transport management measures to improve air quality. Earth Sciences department experience.

Objective

The main objectives of this presentation is to give an overview of:

- Our expertise regarding air quality modelling and its application for the assessment of road transport management measures.

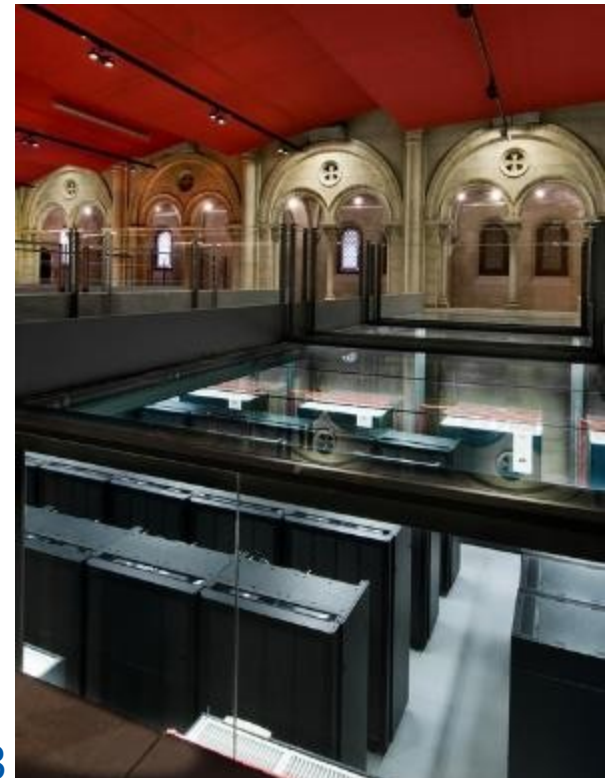- Possible synergies and collaborations between BSC and SEAT.

Potential collaborations:

- To analyze emission reductions (both air quality and green house gases; GHG) due to fleet renewal (electrified vehicles, new emission standards, etc.)

- To assess air quality related impacts due to fleet renewal.

- Combine observational data (massive sensor networks) with modelling techniques thanks to the availability of supercomputing resources an our experience in Big Data and internet of things.

BSC is the National Supercomputing Facility in Spain. BSC manages MareNostrum, one of the most powerful supercomputers in Europe. The mission of BSC is to investigate, develop and manage information technology in order to facilitate scientific progress.
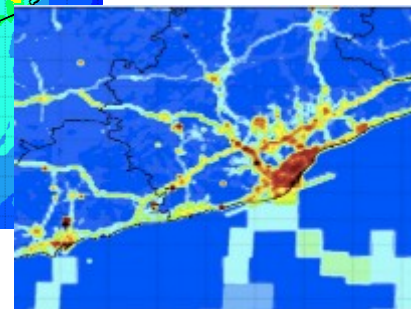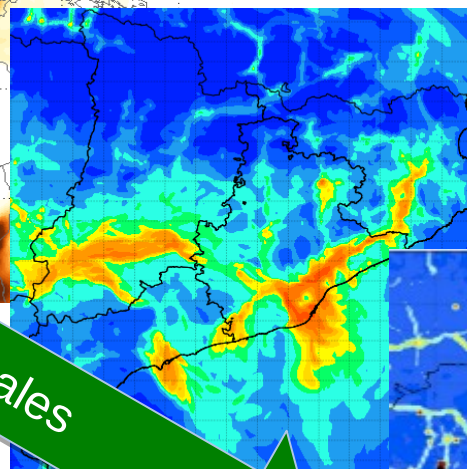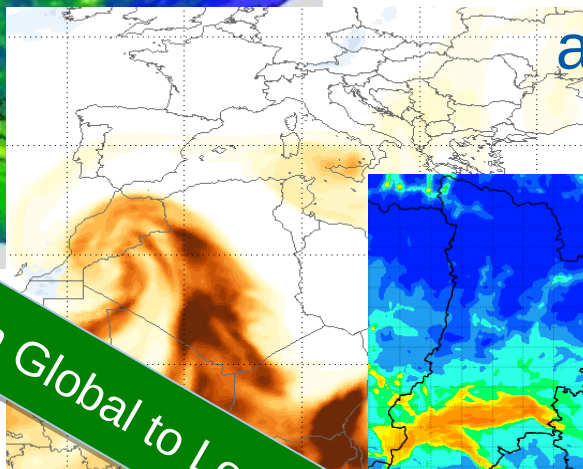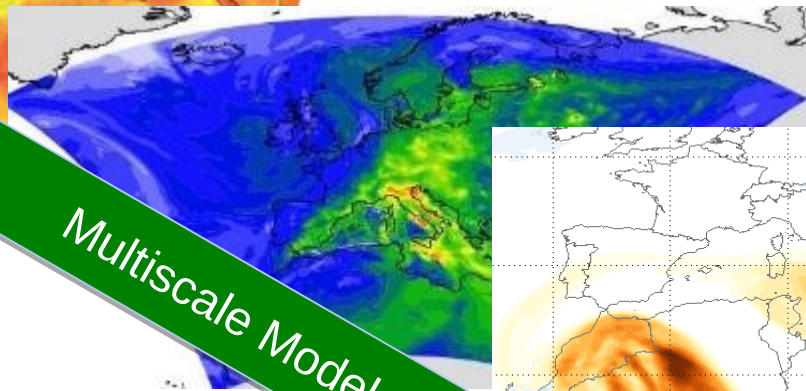

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MareNostrum 3

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Towards modeling the Earth System:

Development and implementation of regional and global state-of-the-art models for air quality, meteorology, climate and health studies
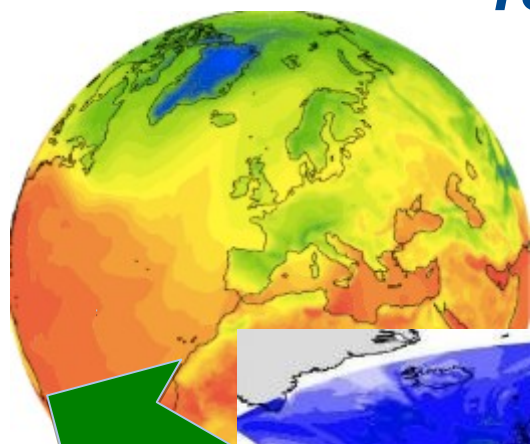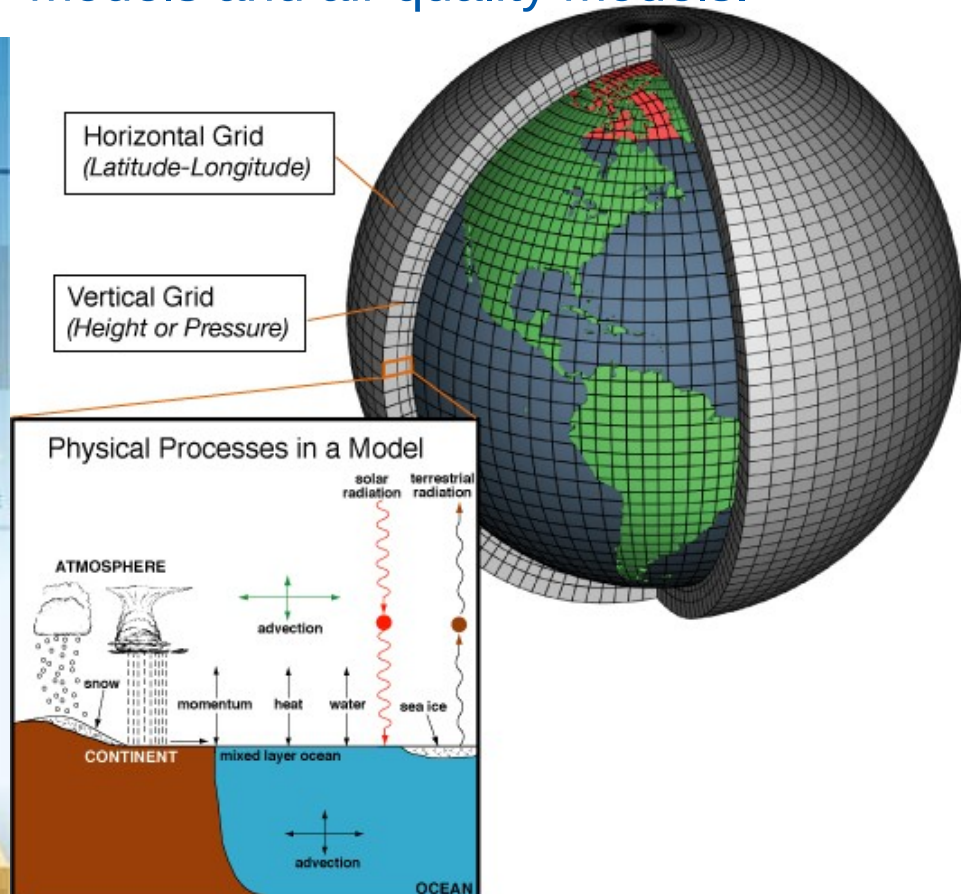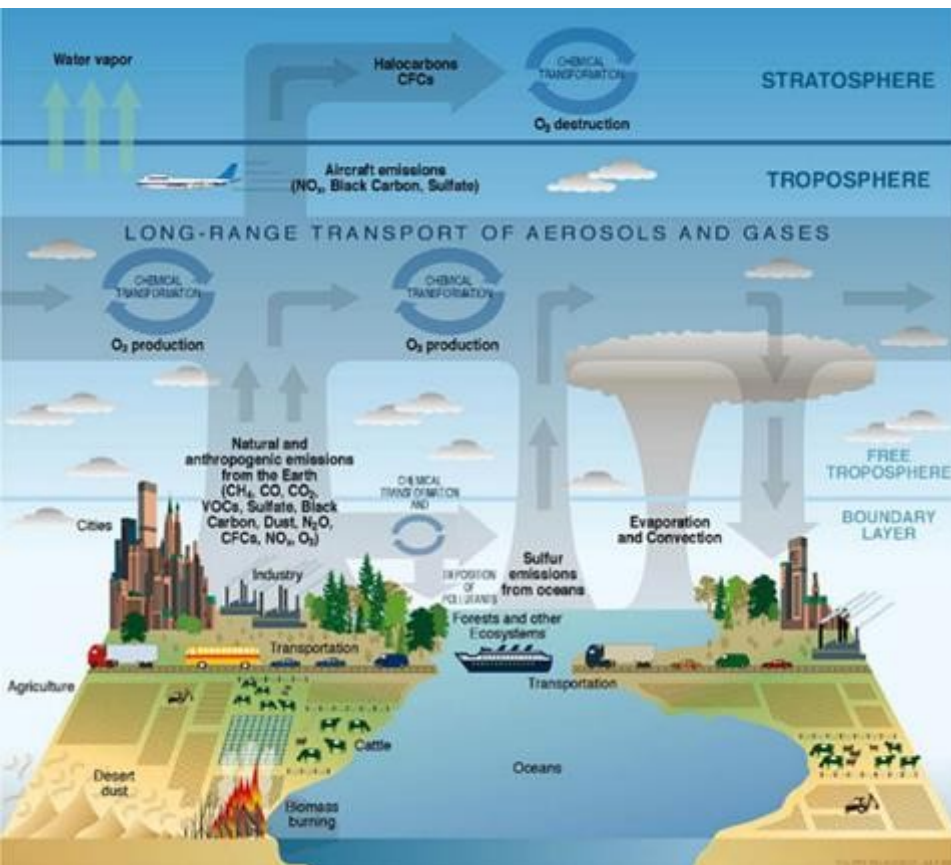
Multiscale Models from Global to Local Scales

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We model atmospheric composition processes by applying **air quality modelling systems**

Air quality modelling systems resolve atmospheric dynamics by combining: emission models, meteorological models and air quality models.
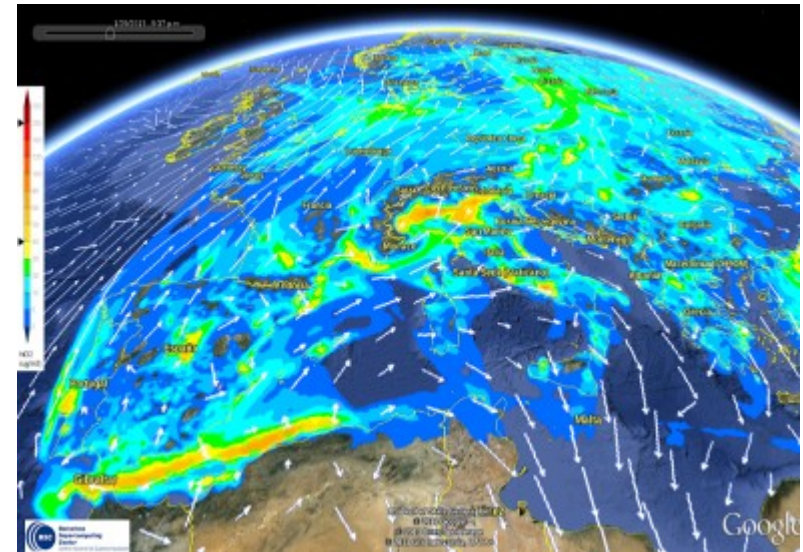
By combining highly qualified scientific researchers and in-house software and model developers, BSC has developed a complete range of air quality modelling tools to meet user requirements.

Main tools:
- Air quality model: NMMB/BSC-AQ
- Emission model: HERMES
- Air quality forecast system: CALIOPE
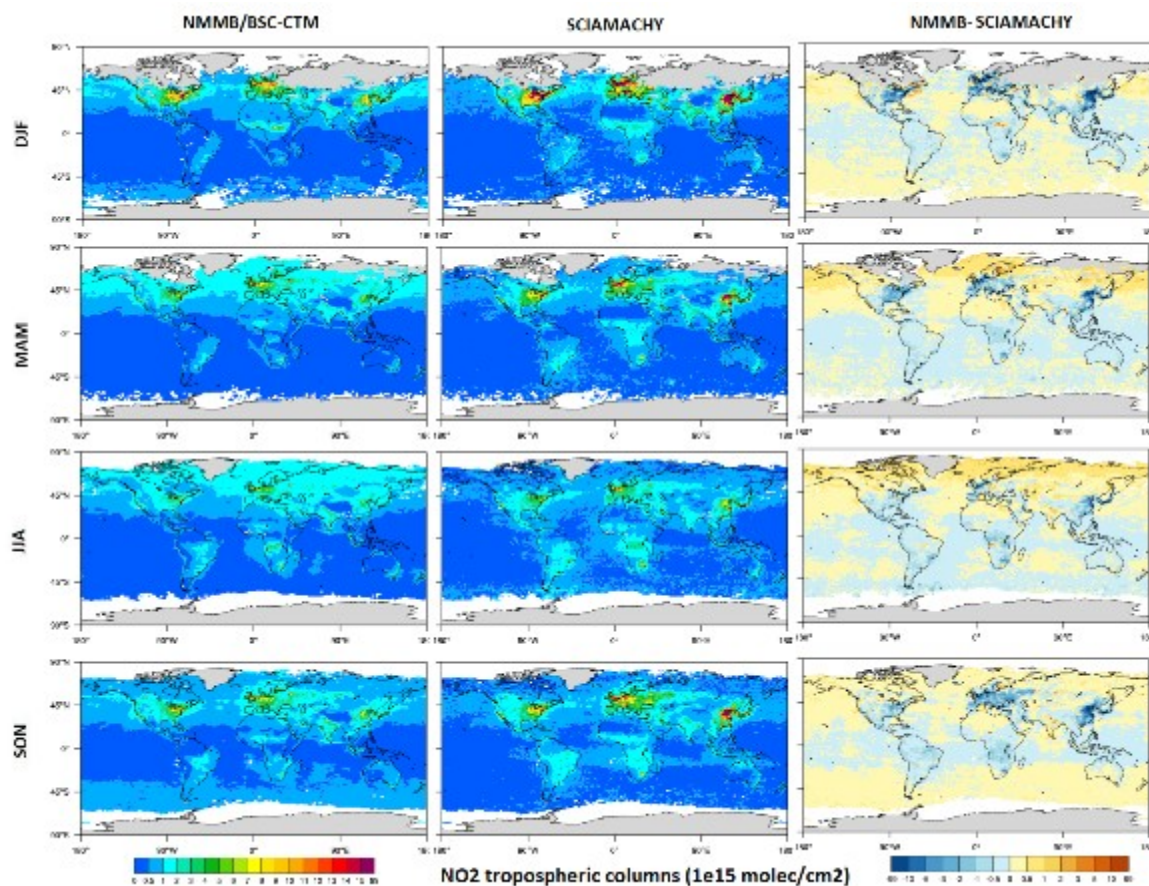- Decision support tool: Source apportionment
- Urban scale models

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The NMMB/BSC-AQ is an online multi-scale atmospheric model designed and developed at BSC-CNS in collaboration with NCEP, NASA and IRI.
(Spada et al., 2014 and Badia et al., 2014)

- Multi-escale: from global (e.g at 0.1º spatial resolution) to regional scales.
- Fully on-line coupling meteo-chemistry.
- Forecast and diagnostic mode

NMMB/BSC-CTM   SCIAMACHY   NMMB- SCIAMACHY

NO2 tropospheric columns (1e15 molec/cm2)

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NO$_2$ tropospheric columns modelled with the NMMB/BSC-AQ model (left) and comparison with satellite observations (Schicachy).

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Air quality forecast systems provide air quality related information for the coming days and for the application of short term action plans for air quality managers.

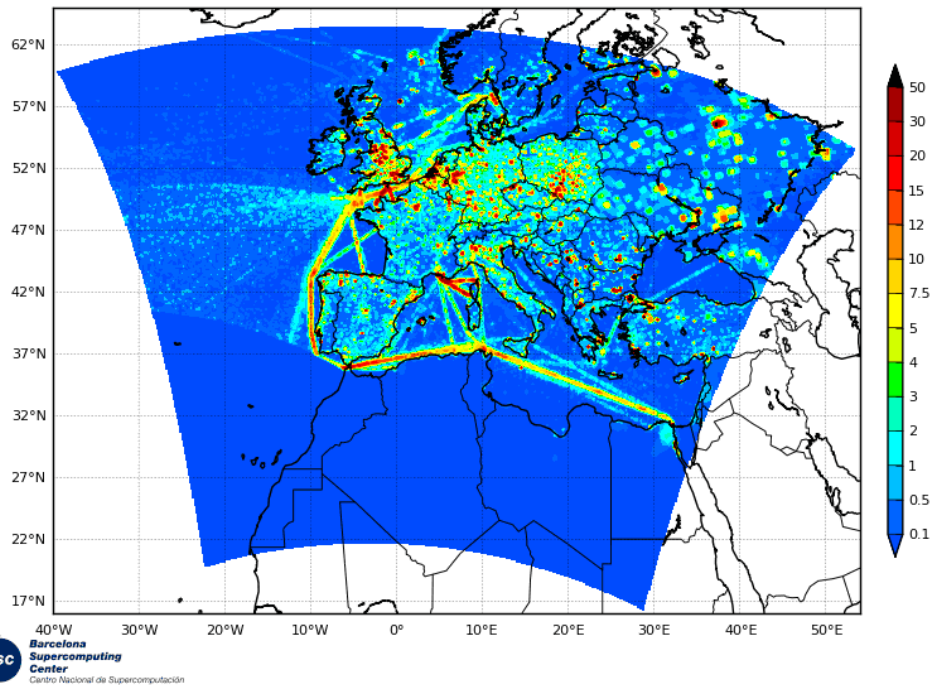Information is delivered using both online or custom applications:
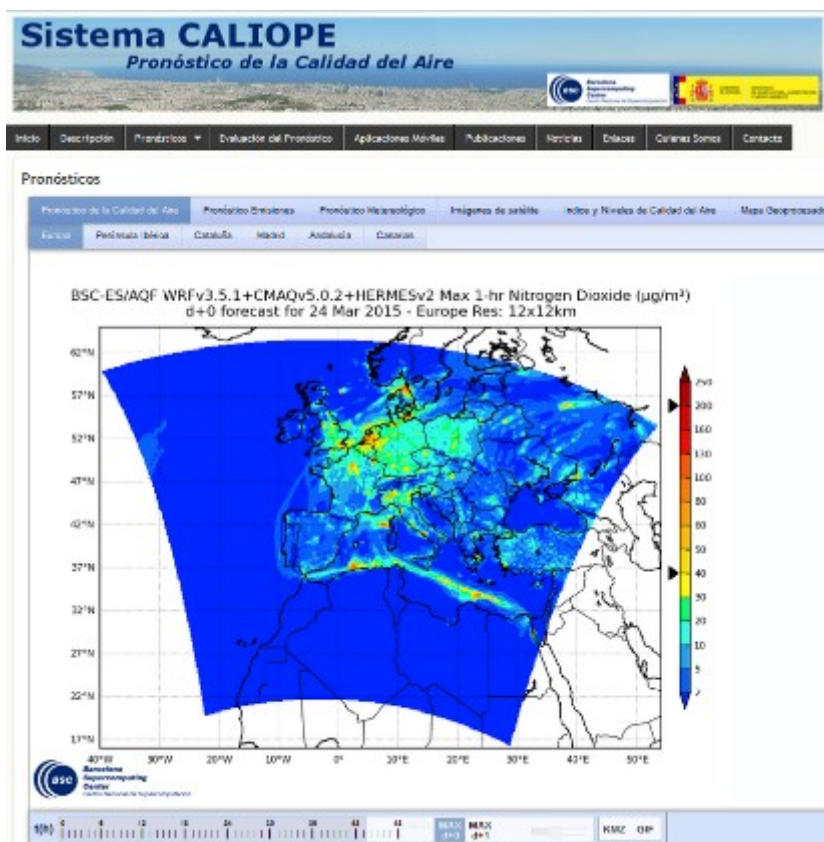
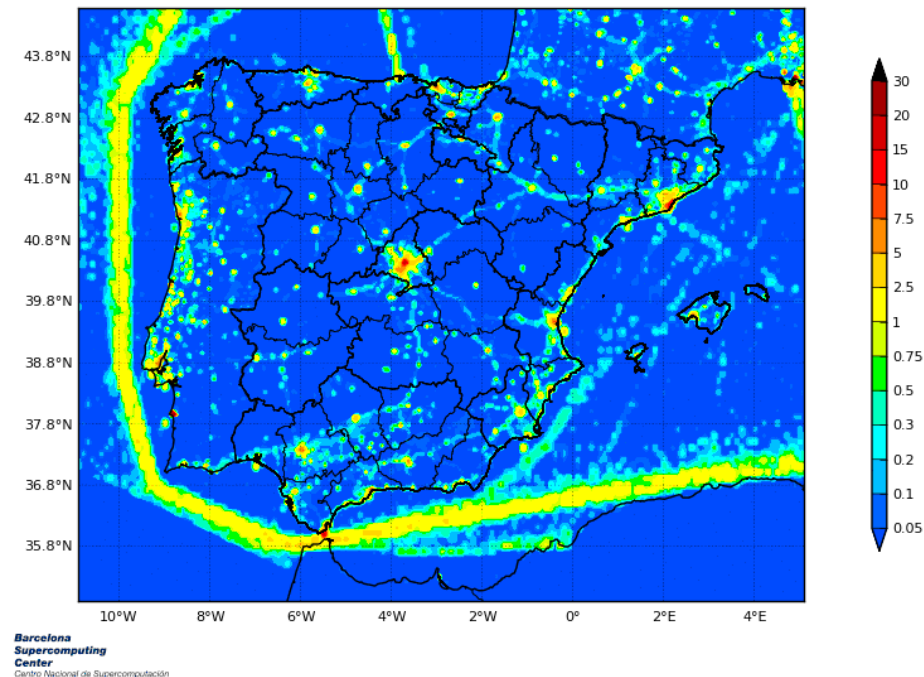

www.bsc.es/caliope

HERMESv2 (Guevara et al, 2013)

HERMESv2.0 is a in-house bottom-up emission model that estimates anthropogenic and biogenic emissions at a high spatial and temporal resolutions (1 km x 1 km, 1h).

Hourly NO$_2$ emissions for Europe and Spain

Tools.
Source apportionment

Source apportionment is a decision support tool which provides comprehensive description of air quality related problems by relating emission sources and their air quality impacts.
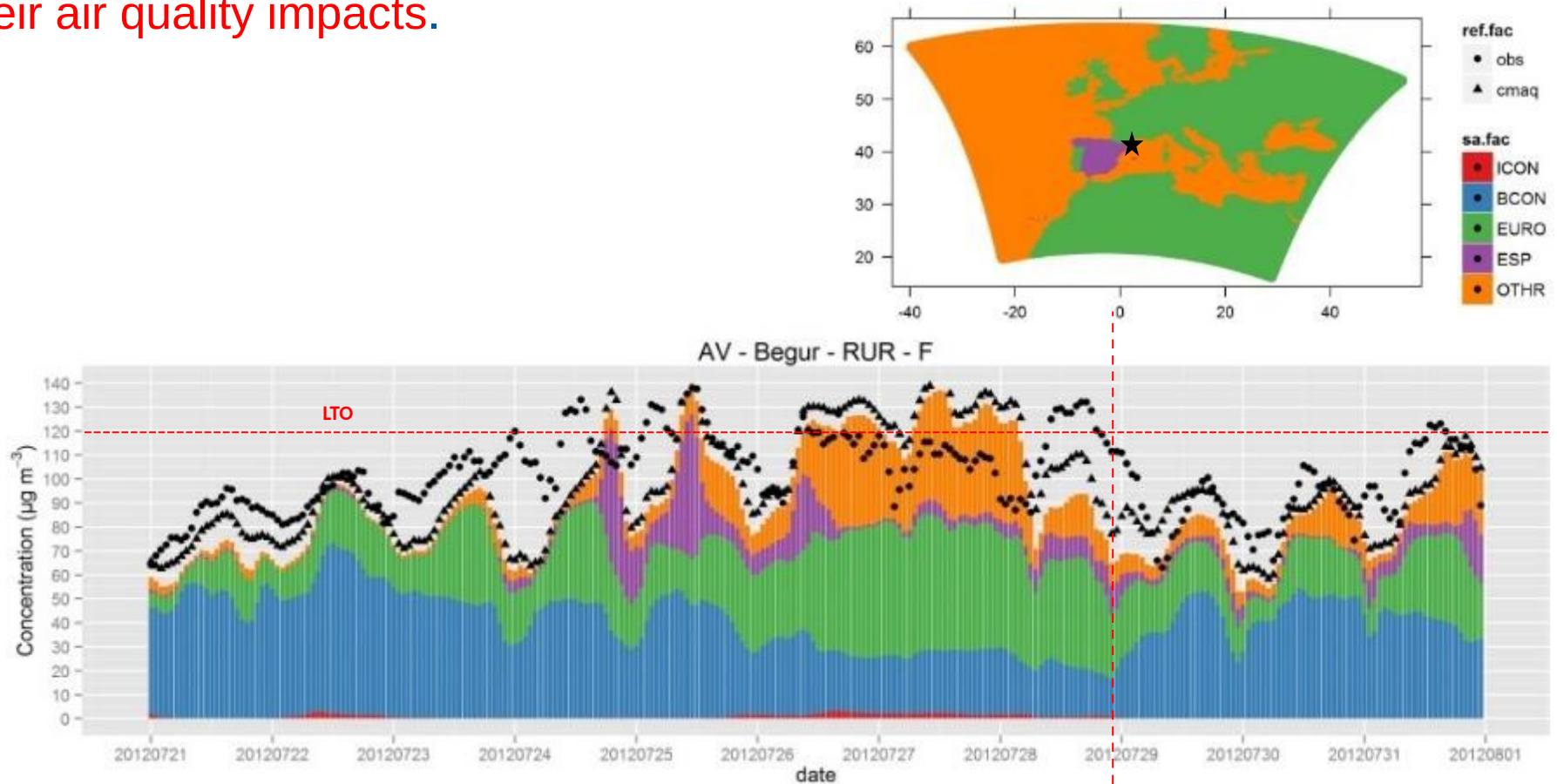
Air quality impacts by regions: Spain, Europe and others.

Micro-scale models to further assess air quality related problems in urban environments.

Currently, we are exploring the potential benefits of these kinds of models in collaboration with TNO, CSIC and U. Averio-CESAM.

Left: Satellite image of Barcelona. Detail of Passeig de Gràcia street, from Diagonal street (top left corner) to Plaça Catalunya (bottom right corner). Right: For the same area: Locations of several traffic stations (red dots) and the corresponding road network with traffic information. Detailed information of the buildings including the height of each building.
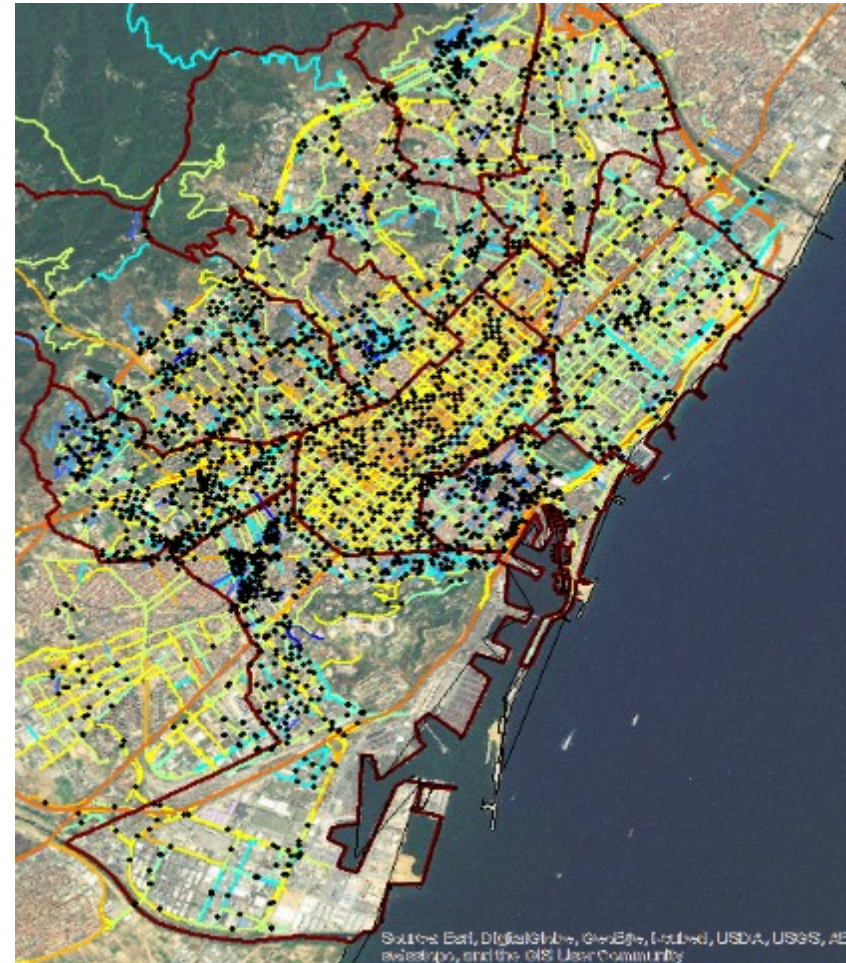
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As air quality management problems become more complex, there is a need for enhanced air quality and exposure monitoring capabilities.

Mobile sensor networks have the potential to developing spatially resolved data on air quality in local areas and allow monitoring near emissions sources helping communities understand near-source exposures.

The BSC is involved in the GrowSmarter European project which aims to simulate city uptake of smart solutions.


Source: Esri, DigitalGlobe, GeoEye, i-cubed, USDA, USGS, AEX, Getmapping, and the GIS User Community

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Experience on emission and air quality assessments. Several works have analyzed the impact of different management measures regarding road transport sector:
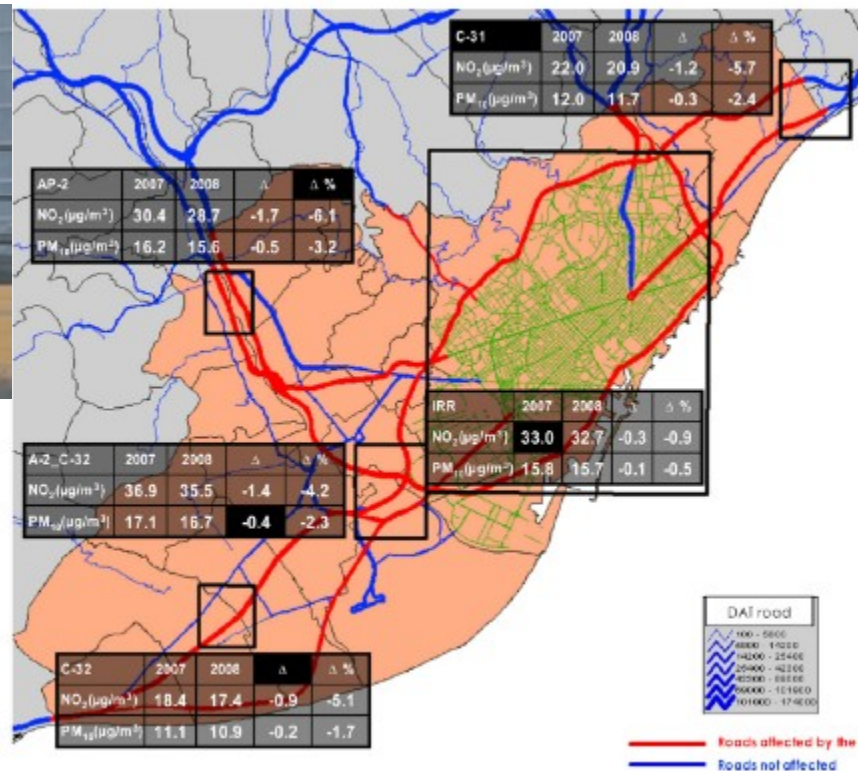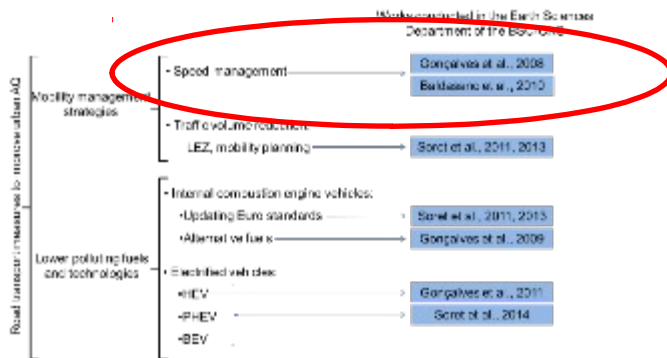
Works conducted in the Earth Sciences Department of the BSC-CNS
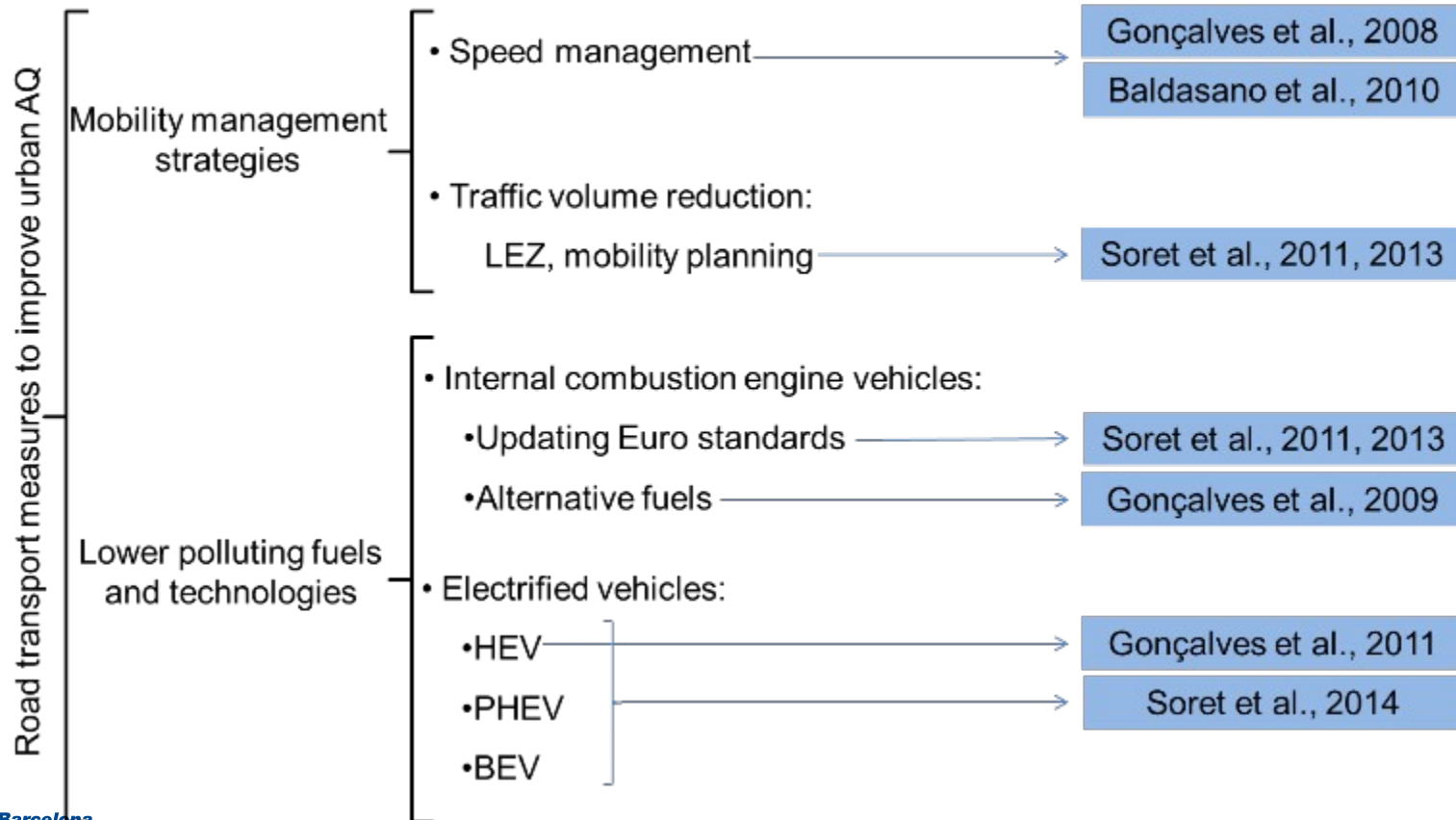
The earth sciences department was working in the technical commission to implement speed management in the road access to Barcelona.


Generalitat de Catalunya
gencat.cat

Fig. 5. Summary of the impacts on air quality (NO₂ and PM10) of the speed limitation measure for different areas of study within the Barcelona Metropolitan Area (in red, roads affected by the measure).
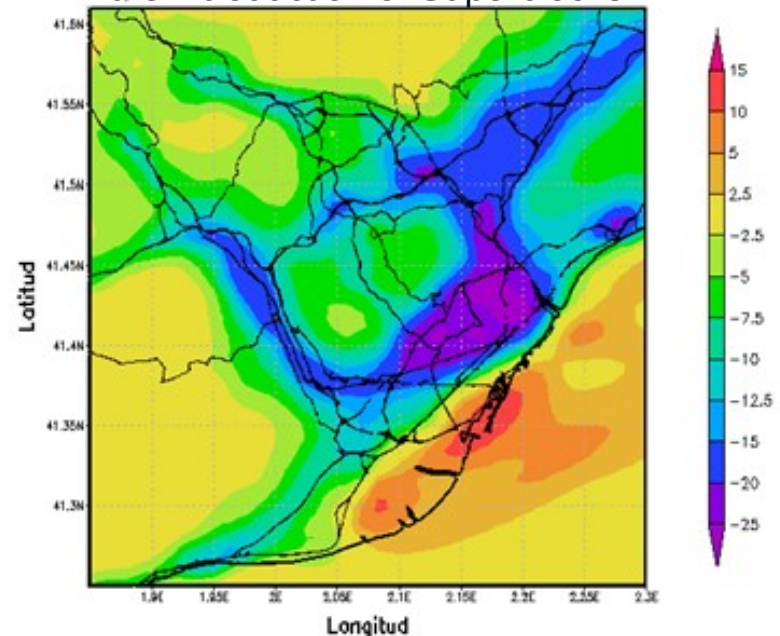
Road transport measures to improve air quality. Traffic volume reduction

The earth sciences department collaborated in the implementation of the superblocks in Barcelona.
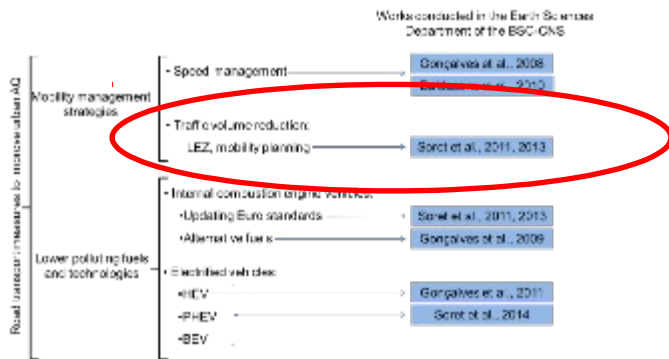
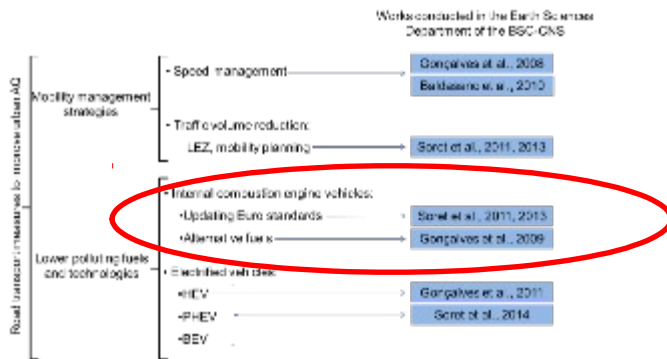NO_2 24 h averaged variations with the introduction of Superblocks

Source: BCNEcologia

(Left) Future Barcelona street network organized in superblocks, the aim of the measure is the reduction of VKT. (Right) This reduction of VKT implies a reduction in emissions and an improvement on air quality.

Two studies have been performed in order to analyze the impact of fleet renewal:
- By introducing natural gas vehicles.
- Introducing new Euro standards in internal combustion vehicles

Vehicular fleet Madrid in 2009. % of VKT per vehicle category
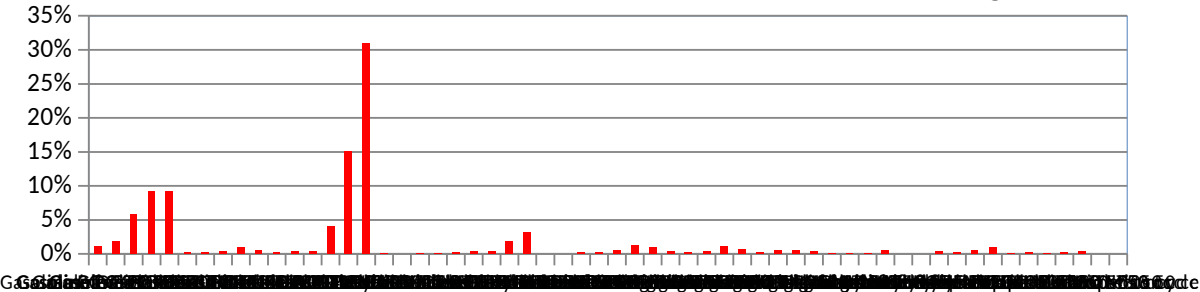
Detailed information of the vehicular fleet is available within HERMES which allows us for comprehensively assess these kind of studies.
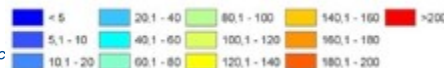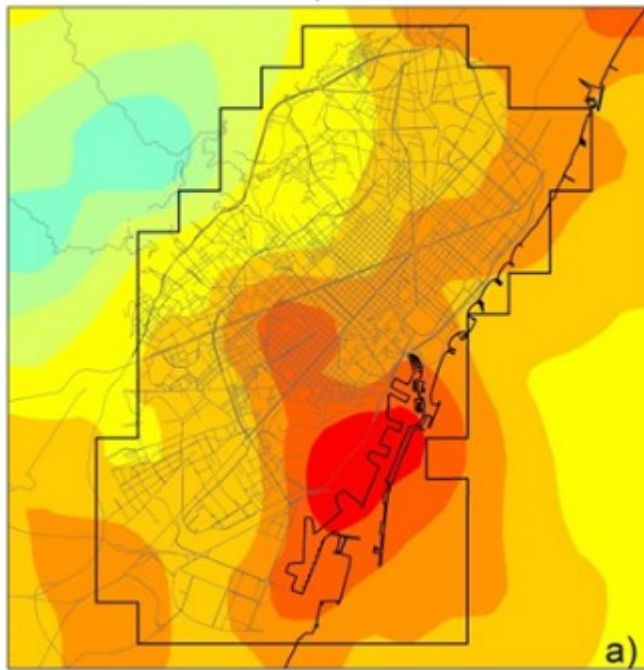
Road transport measures to improve air quality. Fleet electrification
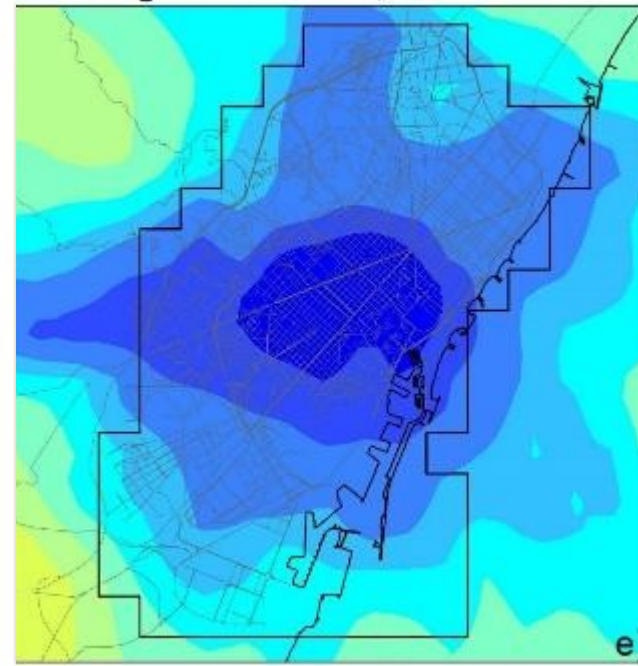
The air quality impacts of fleet electrification has been analyzed for the cities of Barcelona and Madrid.
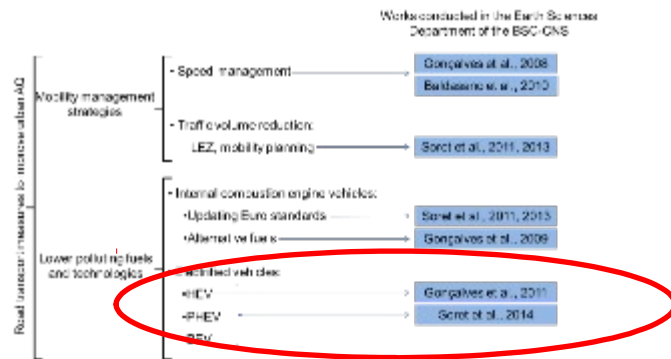
Left: NO_2 maximum h values in Barcelona (red >200 µg/m³)
Right: Reductions due to fleet electrification (blue >25 µg/m³)

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Thank you!

For further information please contact:

oriol.jorba@bsc.es

albert.soret@bsc.es

services-es@bsc.es